WATER RESOURCES REVIEW for

MAY

1973

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

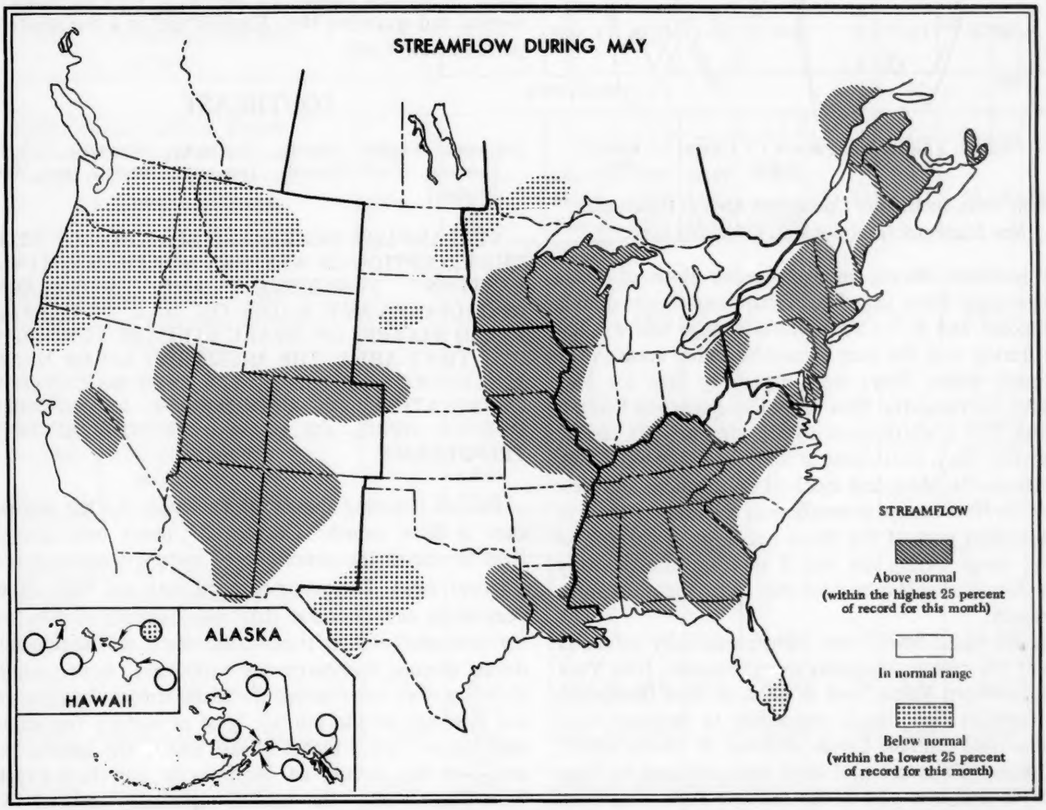
CANADA
DEPARTMENT OF THE ENVIRONMENT
WATER RESOURCES BRANCH

STREAMFLOW AND GROUND–WATER CONDITIONS

Streamflow increased in southern Canada, in Alaska, and in much of the West, and generally decreased in the eastern and central States and in Hawaii.

Flooding continued throughout the month in the lower reaches of the Mississippi River and principal tributaries in Louisiana. Upstream, at Memphis, Tennessee and St. Louis, Missouri, the Mississippi was above flood stage for periods of 63 and 78 days, respectively, ending May 25, breaking flood-stage longevity records established in 1872 and 1844 at those sites. Flow of Mississippi River at Vicksburg, Mississippi, representing runoff from roughly 40 percent of the conterminous United States, was double the normal flow for the month. Flooding occurred also in many southeastern, midwestern, and western States.

Above-normal streamflow conditions occurred in much of eastern and southwestern United States and in parts of the Atlantic Provinces and Quebec in eastern Canada. A large area of below-normal flow persisted in the northwestern States, and smaller areas of below-normal flow occurred in the Province of Manitoba, and in the Dakotas, Florida, Texas, and Hawaii.

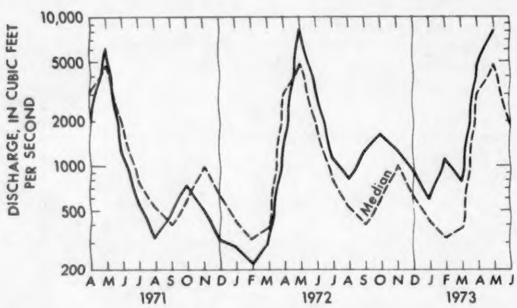


NORTHEAST

[Atlantic Provinces and Quebec; Delaware, Maryland, New York, New Jersey, Pennsylvania, and the New England States]

STREAMFLOW INCREASED IN QUEBEC, AND IN PARTS OF THE ATLANTIC PROVINCES AND PENNSYLVANIA, BUT DECREASED SEASONALLY ELSEWHERE. FLOWS WERE ABOVE THE NORMAL RANGE IN RELATIVELY LARGE AREAS OF THE NORTHERN AND CENTRAL PARTS OF THE REGION, AND IN SMALLER AREAS ON CAPE BRETON ISLAND AND IN NORTHWESTERN PENNSYLVANIA.

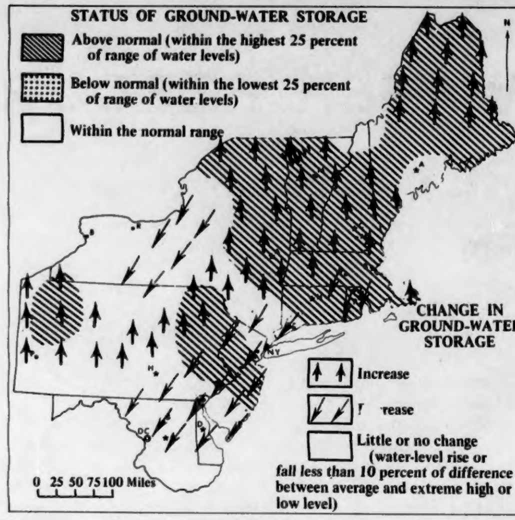
In New Brunswick, high carryover flows from April resulted in above-normal streamflow throughout the Province. The monthly mean discharge of Upsalquitch River at Upsalquitch (drainage area, 877 square miles) was 8,090 cfs, 170 percent of the May median (see graph).



Monthly mean discharge of Upsalquitch River at Upsalquitch, New Brunswick (Drainage area, 877 square miles.)

In southern Maine, monthly mean flow of Little Androscoggin River near South Paris was almost double the median and in the above-normal range where it has been during 4 of the past 5 months. Other areas in the Northeast where flows were especially high for May included south-central New York (Susquehanna River at Conklin, N.Y.), northwestern Pennsylvania (Oil Creek at Rouseville, Pa.), south-central Maryland (Seneca Creek at Dawsonville, Md.), and much of Connecticut and New Jersey. In New Jersey, streamflow at the index station in the southern part of the State has been in the above-normal range during the past 8 months, and monthly mean flow during May was roughly twice the median for the month.

Ground-water levels rose contraseasonally in many parts of the region, especially in northeastern New York State, northern Maine, and in most of New Hampshire and Vermont (see map), responding to recharge from above-normal rainfall. Levels declined in Rhode Island, New Jersey, Delaware, and some areas adjacent to those States, as well as in part of central New York. Monthend levels were above normal in nearly all of New England, eastern New York, and parts of central New Jersey and northeastern and northwestern Pennsylvania. Levels in many wells were highest for May in at least 20 years in central and southern New England and in some adjacent parts of New York.



Map above shows ground-water storage near end of May and change in ground-water storage from end of April to end of May.

SOUTHEAST

[Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia]

STREAMFLOW DECREASED SEASONALLY WITH THE EXCEPTION OF WESTERN NORTH CAROLINA, EASTERN TENNESSEE, AND NORTHERN GEORGIA. HEAVY RAINS ON MAY 27 CAUSED FLASH FLOODS ON SMALL STREAMS THROUGHOUT THAT AREA. THE MISSISSIPPI RIVER NEAR VICKSBURG CRESTED AT 53.1 FEET MAY 13, THE CULMINATION OF FLOOD-FLOW CONDITIONS DURING APRIL ON MANY OF THE RIVER'S TRIBUTARIES.

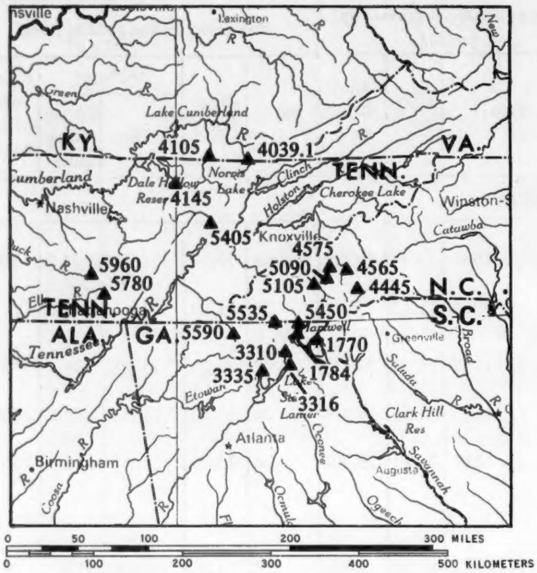
Record breaking floods hit Tennessee for the second time in three months. On May 27, heavy rains caused flash floods in the mountains of eastern Tennessee and adjacent areas. The accompanying map and table show peak stage and discharge data and locations of selected measurement sites in those areas. Most of the rain fell during intense thunderstorms within a 12-hour period. Flooding was most severe on small streams because of the intensity of the rainfall. Most of eastern Tennessee received at least 2 inches of rain and in the hardest hit area—in the vicinity of McMinnville and Falls Creek Falls State Park—the rainfall reportedly totalled 7½ inches. Five people were drowned as a direct result of flooding caused by the storm.

Provisional data; subject to revision

STAGES AND DISCHARGES FOR THE FLOODS OF MAY 1973 AT SELECTED SITES IN GEORGIA, KENTUCKY, TENNESSEE, AND NORTH CAROLINA

WRD station number	Stream and place of determination	Drainage area (square miles)	Period of known floods	Maximum flood previously known			Maximum during present flood				
				Date	Stage (feet)	Discharge (cfs)	Date	Stage (feet)	Discharge		Recurrence interval (years)
									Cfs	Cfs per square mile	
				GEORGIA							
SAVANNAH RIVER BASIN											
2–1770	Chattooga River near Clayton.	207	1915–	Aug. 30, 1940	13.8	29,000	May 28	10.70	19,500	94.2	20
2–1784	Tallulah River near Clayton...	56.5	1964–	Oct. 4, 1964	11.12	(a)	28	11.98	(a)	.....	.....
APALACHICOLA RIVER BASIN											
2–3310	Chattahoochee River near Leaf.	150	1940–	Aug. 23, 1967	15.44	17,500	28	17.50	22,500	150	[b]1.2
2–3316	Chattahoochee River near Cornelia.	315	1958–	Mar. 12, 1963	20.55	26,400	28	20.40	26,000	82.5	20
2–3335	Chestatee River near Dahlonega.	153	1907, 1929–32, 1940–	Aug. 23, 1967	25.17	22,700	28	23.90	20,800	136	35
TENNESSEE RIVER BASIN											
3–5450	Hiwassee River at Presley....	45.5	1942–	Mar. 11, 1952	15.24	5,700	28	13.96	5,080	112	20
3–5535	Nottely River at Nottely Dam near Ivylog.	215	1942–	May 3, 1964	6.63	[c]3,240	28	11.86	[c,d]8,100	.....	.....
3–5590	Toccoa River near Blue Ridge.	233	1931–	Mar. 13, 1950	11.40	[c]8,140	28	13.61	[c,d]10,900	.....	.....
				KENTUCKY							
CUMBERLAND RIVER BASIN											
3–4039.1	Clear Fork at Saxton.......	331	1929, 1968–	1929	41.7	.....	May 28	40.92	22,200	67.1	5
				Dec. 31, 1969	38.59	19,900					
3–4105	South Fork Cumberland River near Stearns.	954	1929, 1942–	March 1929	52.9	.....	28	45.31	93,200	97.7	100
				Dec. 30, 1969	44.00	88,000					
				TENNESSEE							
CUMBERLAND RIVER BASIN											
3–4145	East Fork Obey River near Jamestown.	202	1929, 1943–	March 1929	30.7	.....	May 27	30.3	39,000	193	100
TENNESSEE RIVER BASIN											
3–5405	Emory River at Oakdale.....	764	1927–	Mar. 23, 1929	44.3	195,000	28	38.7	143,000	187	50+
3–5780	*Elk River near Pelham......*	*65.6*	*1951–*	*Mar. 16, 1973*	*14.08*	*15,000*	*27*	*13.4*	*11,000*	*168*	*100*
3–5960	Duck River below Manchester.	107	1902, 1929, 1934–	March 1929	23.2	50,000	27	21.0	44,000	411	25
				NORTH CAROLINA							
TENNESSEE RIVER BASIN											
3–4445	South Fork Mills River at The Pink Beds.	9.99	1925–49, 1965–	Aug. 15, 1928	8.0	2,220	May 28	8.69	3,170	317	100
3–4565	East Fork Pigeon River near Canton.	51.5	1954–	Feb. 13, 1966	10.13	12,100	28	11.19	14,800	287	100
3–4575	Allen Creek near Hazelwood..	14.4	1940, 1949–	Aug. 30, 1940	7.0	[e]6,000	28	4.88	2,120	147	100
3–5090	Scott Creek above Sylva.....	50.7	1940, 1941–	Aug. 30, 1940	8.6	3,200	28	8.84	2,840	56.0	25
3–5105	Tuckasegee River at Dillsboro.	347	1840, 1928–	Aug. 30, 1940	21.96	52,600	28	14.14	20,400	58.8	100

[a] Discharge undetermined.
[b] Ratio of discharge to that of the 50-year flood.
[c] Regulated.
[d] Discharge based on spillway and turbine ratings.
[e] From studies by Tennessee Valley Authority.



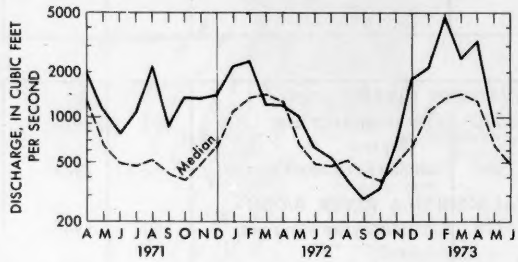
Locations of stream-gaging stations described in table of peak stages and discharges on page 3.

Another storm area, on May 27, was in western North Carolina where tornadoes and thunderstorms produced rains of from 5½ to 7 inches. Severe flooding on small mountain streams caused at least 8 deaths. A total of 30 bridges were reported washed out or badly damaged across the area. Heavy damage occurred to crops and roads.

Floods in north Georgia also resulted from intense rains occurring the evening of May 27. Rainfall amounts varied from 5 to 9 inches during a 4-hour period. The larger amounts of rain occurred in the extreme northeast, extending from Ellijay to Clayton. Information from TVA indicated that several lakes in the Tennessee River basin were filled to overflowing resulting in record flows at Nottely River at Nottely Dam near Ivylog, and Toccoa River near Blue Ridge, Ga. The Blue Ridge station reported the highest stage since regulation began in December 1930 (see table).

Three index gaging stations, in the area affected by flooding, recorded new monthly and daily maximums for May. Emory River at Oakdale, Tennessee (No. 3-5405 in the flood table) had a monthly mean discharge of 5,777 cfs and a daily discharge on the 28th of 72,500 cfs. In western North Carolina, French Broad River at Asheville (drainage area, 945 square miles) had a monthly mean discharge of 4,824 cfs and a daily mean of 21,200 cfs on the 28th, the highest in May since record began in 1895. In northern Georgia, Oostanaula River at Resaca (drainage area, 1,610 square miles), recorded a monthly mean discharge of 7,201 cfs and a daily mean on the 30th of 26,200 cfs, highest for May in 81 years of record.

To the east of the flood area, Lynches River at Effingham, S.C., declined into the normal range after having been in the above-normal range for the past five months (see graph).



Monthly mean discharge of Lynches River at Effingham, S.C. (Drainage area, 1,030 square miles.)

All index gaging stations in Mississippi were above normal for the third consecutive month. On May 13, the Mississippi River at Vicksburg crested at 53.1 ft. with a discharge of 1,962,000 cfs. Its monthly mean discharge, 1,826,000 cfs, was the third highest since 1928; the monthly discharge in February 1937 was 1,944,000 cfs and in April 1945 was 1,848,000 cfs.

In northern Florida, Suwannee River at Branford (see table of Large Rivers), had a new maximum monthly and daily mean discharge for May of 24,000 cfs and 33,400 cfs (on the 1st) respectively, due to high carryover from the flooding last month. This is the fourth consecutive month in which discharge has been above the normal range. In north-central Florida, flow of Silver Springs increased to 762 cfs; 94 percent of normal. In contrast, this is the fourth consecutive month in which the southeast part of the State has been in the below-normal range. Flow southward through the Tamiami Canal outlets, 40-mile bend to Monroe, decreased to zero. The flow of Miami Canal at Miami decreased also to zero, which happened last in May 1967.

Ground-water levels generally rose in Mississippi and in the mountains and Piedmont area of North Carolina; and declined in West Virginia (except in three southeastern counties), Kentucky, Alabama, central and northern Florida, and in the Coastal Plain of North Carolina. Monthend levels were again above average in most of Alabama, Kentucky, and North Carolina; and also in the western one third and extreme eastern part of West Virginia. Elsewhere in that State, monthend levels were below average. In northern Kentucky near Louisville, the level in the key observation well in the Ohio River valley was again at a new highest level in the 27 years of record. In southeastern Florida, levels rose in Palm Beach, Broward, and north Dade Counties, but continued to decline in central Dade County and the lower Everglades; monthend levels were below average in most wells. In the heavily pumped Savannah area of coastal Georgia, the level declined in the observation

well, reaching the lowest end-of-May level in the 17 years of record.

WESTERN GREAT LAKES REGION

[Ontario; Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin]

STREAMFLOW INCREASED IN WISCONSIN AND IN PARTS OF ONTARIO, MICHIGAN, OHIO, AND ILLINOIS, AND DECREASED ELSEWHERE IN THE REGION. FLOWS WERE ABOVE THE NORMAL RANGE IN A LARGE AREA CENTERED ON WISCONSIN, AND IN NORTHEASTERN OHIO, AND WERE BELOW NORMAL IN SOUTHWESTERN ONTARIO. SOME LOCAL FLOODING CONTINUED FROM APRIL IN ILLINOIS.

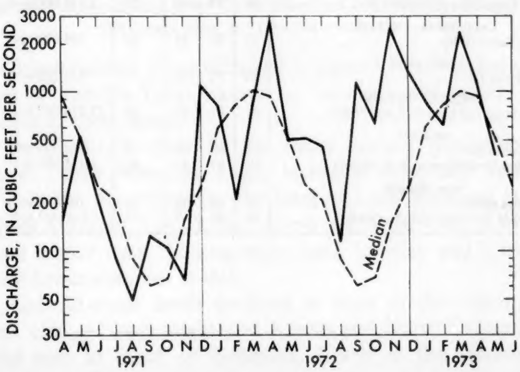
Streamflow increased and remained above the normal range in Wisconsin where it has been during most of the past 10 months. Monthly mean discharges of principal streams in the State, including the Fox, Chippewa, and Wisconsin Rivers, were 2½ to more than 3 times the median for May. Many streams were near bankfull at monthend.

In Illinois, flooding that began in April continued on some streams into May. Flow of Pecatonica River at Freeport (drainage area, 1,330 square miles), in northern Illinois, remained above the normal range for the 10th consecutive month, and the monthly mean discharge of 3,677 cfs was the highest for May since records began in 1914.

Streamflow increased contraseasonally in northeastern Ohio where flow during May at the index station, Little Beaver Creek near East Liverpool, was nearly double the monthly mean.

In east-central Minnesota, monthly mean discharge of Crow River at Rockford again was above the normal range where it has been during 31 of the past 32 months. Persistent rains during early May in northern Michigan resulted in above-normal monthly discharge in the Sturgeon River basin.

Flow of Mississinewa River at Marion, in northeastern Indiana, decreased seasonally (see graph) and was generally typical of streamflow in the eastern half of the region, except northeastern Ohio.



Monthly mean discharge of Mississinewa River at Marion, Ind. (Drainage area, 682 square miles.)

In southwestern Ontario, flow at the index station, English River at Umfreville, increased seasonally but was below the normal range. Precipitation in the area during May was about half of normal.

Ground-water levels declined in most of the region. Monthend levels were near average in Indiana and Ohio, and remained above average in Michigan, Minnesota, and Wisconsin. In the observation well in south-central Michigan, monthend levels for three consecutive months have equalled or exceeded the previous highest end-of-month level recorded in the past 24 years. In some parts of Wisconsin, levels in May were the highest in more than 25 years—a result of substantial recharge from rains that occurred last summer and autumn and additional heavy rains this spring; the level in one well in Marathon County in the central part of the State, rose more than 10 feet since early March. In Minnesota, in wells tapping the heavily pumped aquifers in the Minneapolis-St. Paul area, levels continued to decline and remained below average.

MIDCONTINENT

[Manitoba and Saskatchewan; Arkansas, Iowa, Kansas, Louisiana, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas]

STREAMFLOW INCREASED IN SOUTHERN MANITOBA AND CENTRAL SOUTH DAKOTA AND DECREASED IN ALL OTHER PARTS OF THE REGION. FLOWS WERE BELOW THE NORMAL RANGE IN SMALL AREAS OF NORTH AND SOUTH DAKOTA AND IN WESTERN TEXAS, AND REMAINED ABOVE NORMAL IN PARTS OF IOWA, MISSOURI AND EASTERN TEXAS. FLOODING CONTINUED ALONG THE MAIN STEM OF MISSISSIPPI RIVER AND SOME PRINCIPAL TRIBUTARIES IN LOUISIANA. FLOODING OCCURRED ALSO IN KANSAS, NEBRASKA, AND IOWA.

In Louisiana, flooding continued on Mississippi, Red, and Ouachita-Black Rivers throughout the month. Monthly mean discharges of Mississippi River at Vicksburg and Red River at Alexandria, Louisiana, were about twice the median for May, and the peak discharge of 86,900 cfs on Ouachita River at Monroe, Louisiana, was 4th highest in record that began in 1932. Flooding along Black River near Jonesville, which caused the evacuation of nearly 400 families, continued during May and most roads in the area remain inundated at monthend.

At St. Louis, Missouri and Memphis, Tennessee, the Mississippi River fell below flood stage on May 25, after establishing a new record of 63 days above flood stage at Memphis (the longest sustained flood since at least 1872), and 76 days at St. Louis, exceeding by 18 days the record established there in 1844.

Downstream from Vicksburg, diversion of flow from the Mississippi River to the Gulf through the Old River

Provisional data; subject to revision

USABLE CONTENTS OF SELECTED RESERVOIRS NEAR END OF MAY 1973

[Contents are expressed in percent of reservoir capacity. The usable storage capacity of each reservoir is shown in the column headed "Normal maximum."]

Reservoir Principal uses: F—Flood control I—Irrigation M—Municipal P—Power R—Recreation W—Industrial	End of Apr. 1973	End of May 1973	End of May 1972	Average for end of May	Normal maximum
	Percent of normal maximum				
NORTHEAST REGION					
NOVA SCOTIA					
Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Ponhook Reservoirs (P)	78	84	98	77	223,400 (a)
QUEBEC					
Gouin (P)	57	71	43	66	6,487,000 ac-ft
Allard (P)	91	94	91	86	280,600 ac-ft
MAINE					
Seven reservoir systems (MP)	98	99	96	89	179,300 mcf
NEW HAMPSHIRE					
Lake Winnipesaukee (PR)	106	108	107	100	7,200 mcf
Lake Francis (FPR)	64	88	88	81	4,326 mcf
First Connecticut Lake (P)	71	95	99	86	3,330 mcf
VERMONT					
Somerset (P)	87	97	94	86	2,500 mcf
Harriman (P)	70	75	78	87	5,060 mcf
MASSACHUSETTS					
Cobble Mountain and Borden Brook (MP)	93	94	95	90	3,394 mcf
NEW YORK					
Great Sacandaga Lake (FPR)	100	100	98	97	34,270 mcf
Indian Lake (FMP)	100	109	106	104	4,500 mcf
New York City reservoir system (MW)	100	104	100	.....	547,500 mg
NEW JERSEY					
Wanaque (M)	100	100	100	96	27,730 mg
PENNSYLVANIA					
Wallenpaupack (P)	82	90	90	85	6,875 mcf
Pymatuning (FMR)	102	102	100	99	8,191 mcf
MARYLAND					
Baltimore municipal system (M)	101	101	101	93	85,340 mg
SOUTHEAST REGION					
NORTH CAROLINA					
Bridgewater (Lake James) (P)	100	100	98	91	12,580 mcf
High Rock Lake (P)	100	96	90	81	10,230 mcf
Narrows (Badin Lake) (P)	100	99	97	101	5,616 mcf
SOUTH CAROLINA					
Lake Murray (P)	95	96	96	81	70,300 mcf
Lakes Marion and Moultrie (P)	89	86	91	77	81,100 mcf
SOUTH CAROLINA--GEORGIA					
Clark Hill (FP)	78	86	77	74	75,360 mcf
GEORGIA					
Burton (PR)	98	102	98	92	104,000 ac-ft
Lake Sidney Lanier (FMPR)	65	70	65	67	1,686,000 ac-ft
Sinclair (MPR)	82	92	95	94	214,000 ac-ft
ALABAMA					
Lake Martin (P)	100	100	100	94	1,373,000 ac-ft
TENNESSEE VALLEY					
Clinch Projects: Norris and Melton Hill Lakes (FPR)	57	83	78	63	1,560,000 cfsd
Holston Projects: South Holston, Watauga, Boone, Fort Patrick Henry, and Cherokee Lakes (FPR)	85	91	88	68	1,452,000 cfsd
Douglas Lake (FPR)	83	97	88	68	703,100 cfsd
Hiwassee Projects: Chatuge, Nottely, Hiwassee, Apalachia, Blue Ridge, Ocoee 3, and Parksville Lakes (FPR)	87	95	90	82	512,200 cfsd
Little Tennessee Projects: Nantahala, Thorpe, Fontana, and Chilhowee Lakes (FPR)	92	99	94	83	745,200 cfsd
WESTERN GREAT LAKES REGION					
WISCONSIN					
Chippewa and Flambeau (PR)	99	99	93	86	15,900 mcf
Wisconsin River (21 reservoirs) (PR)	92	94	88	82	17,400 mcf
MINNESOTA					
Mississippi River headwater system (FMR)	28	29	40	38	1,640,000 ac-ft

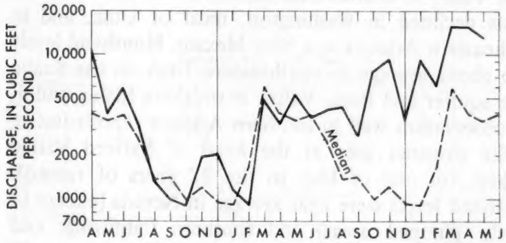
Reservoir Principal uses: F—Flood control I—Irrigation M—Municipal P—Power R—Recreation W—Industrial	End of Apr. 1973	End of May 1973	End of May 1972	Average for end of May	Normal maximum
	Percent of normal maximum				
MIDCONTINENT REGION					
NORTH DAKOTA					
Lake Sakakawea (Garrison) (FIPR)	89	91	93	.....	22,640,000 ac-ft
NEBRASKA					
Lake McConaughy (IP)	90	92	90	78	1,948,000 ac-ft
OKLAHOMA					
Keystone (FPR)	296	113	89	96	661,000 ac-ft
Lake O' The Cherokees (FPR)	131	104	94	92	1,492,000 ac-ft
Tenkiller Ferry (FPR)	183	117	97	101	628,200 ac-ft
Lake Altus (FIMR)	53	68	24	64	134,500 ac-ft
Eufaula (FPR)	160	104	86	87	2,378,000 ac-ft
OKLAHOMA--TEXAS					
Lake Texoma (FMPRW)	121	105	90	103	2,722,000 ac-ft
TEXAS					
Possum Kingdom (IMPRW)	93	91	97	83	724,500 ac-ft
Buchanan (IMPW)	77	76	96	84	955,200 ac-ft
Bridgeport (IMW)	58	60	87	70	270,900 ac-ft
Eagle Mountain (IMW)	100	100	92	91	182,700 ac-ft
Medina Lake (I)	98	98	100	50	254,000 ac-ft
Lake Travis (FIMPRW)	100	99	95	80	1,144,000 ac-ft
Lake Kemp (IMW)	51	53	41	55	461,800 ac-ft
THE WEST					
ALBERTA					
Spray (P)	27	32	36	22	210,000 ac-ft
Lake Minnewanka (P)	52	65	56	33	199,700 ac-ft
St. Mary (I)	74	84	75	79	320,800 ac-ft
WASHINGTON					
Franklin D. Roosevelt Lake (IP)	0	33	26	75	5,232,000 ac-ft
Lake Chelan (PR)	27	62	71	75	676,100 ac-ft
IDAHO--WYOMING					
Upper Snake River (7 reservoirs) (IMP)	76	83	75	82	4,282,000 ac-ft
WYOMING					
Pathfinder, Seminoe, Alcova, Kortes, and Glendo Reservoirs (I)	70	97	78	44	3,016,000 ac-ft
Buffalo Bill (IP)	46	57	38	76	421,300 ac-ft
Boysen (FIP)	65	85	68	63	802,000 ac-ft
Keyhole (F)	84	87	89	38	199,900 ac-ft
COLORADO					
John Martin (FIR)	12	12	0	16	364,400 ac-ft
Colorado–Big Thompson project (I)	73	83	83	61	722,600 ac-ft
Taylor Park (IR)	39	55	95	75	106,000 ac-ft
COLORADO RIVER STORAGE PROJECT					
Lake Powell; Flaming Gorge, Navajo, and Blue Mesa Reservoirs (IFPR)	50	61	56	.....	31,276,500 ac-ft
UTAH--IDAHO					
Bear Lake (IPR)	79	87	92	66	1,421,000 ac-ft
CALIFORNIA					
Hetch Hetchy (MP)	12	76	63	69	360,400 ac-ft
Lake Almanor (P)	75	88	81	60	1,036,000 ac-ft
Shasta Lake (FIPR)	97	100	96	92	4,377,000 ac-ft
Millerton Lake (FI)	79	88	69	81	503,200 ac-ft
Pine Flat (FI)	55	79	57	70	1,014,000 ac-ft
Isabella (FIR)	20	50	22	39	551,800 ac-ft
Folsom (FIP)	75	98	98	91	1,000,000 ac-ft
Lake Berryessa (FIMW)	101	98	83	87	1,600,000 ac-ft
Clair Engle Lake (Lewiston) (P)	89	98	100	95	2,438,000 ac-ft
CALIFORNIA--NEVADA					
Lake Tahoe (IPR)	75	88	85	69	744,600 ac-ft
NEVADA					
Rye Patch (I)	106	92	96	.....	157,200 ac-ft
ARIZONA--NEVADA					
Lake Mead and Lake Mohave (FIMP)	81	81	67	67	27,970,000 ac-ft
ARIZONA					
San Carlos (IP)	81	89	7	17	948,600 ac-ft
Salt and Verde River system (IMPR)	97	99	41	46	2,073,000 ac-ft
NEW MEXICO					
Conchas (FIR)	77	89	36	77	352,600 ac-ft
Elephant Butte and Caballo (FIPR)	18	26	7	29	2,539,000 ac-ft

[a] Thousands of kilowatt-hours.

Control Structure (about 500,000 cfs), the Morganza Control Structure (about 100,000 cfs), and Bonnet Carre Spillway (about 180,000 cfs) was continued throughout the month. These diversions amounted to about 40 percent of the flow at Vicksburg.

The South Platte River flood peak that originated in Colorado May 6, moved into Nebraska May 11. Peak stages and discharges in the reach from the State line (near Julesburg, Colorado) to North Platte, were lower than those of the flood of June 1965, but along the main stem of Platte River, downstream from the confluence of South Platte and North Platte Rivers, peak discharges exceeded those of June 1965 and were highest since records began in 1936. Lowland flooding occurred in the lower Platte River basin (in the eastern part of the State) as a result of rains in that area May 26–28.

In Kansas, flash flooding caused by about 5½ inches of rain, occurred in a small area near Topeka on May 21. Two persons were drowned. In Iowa, heavy rains that began late in April and continued into May, caused some lowland flooding, and contributed to above-normal monthly mean discharges in much of the State. The mean flow during May at the index station, Cedar River at Cedar Rapids, in eastern Iowa, was 13,044 cfs, highest for the month since records began in 1902, and was above the normal range for the 11th consecutive month (see graph). In the north-central and southwestern parts of the State, flows were about 4 to 7 times the medians for May.



Monthly mean discharge of Cedar River at Cedar Rapids, Iowa (Drainage area, 6,510 square miles.)

Below-normal flows occurred in eastern North Dakota and in western Texas, caused by below-average precipitation in those areas.

In Manitoba, flow at the index station, Waterhen River below Waterhen Lake, increased seasonally and was in the normal range. The level of Lake Winnipeg at Gimli averaged 714.22 feet above mean sea level, 0.73 foot higher than the long-term mean for May and 0.14 foot lower than last month.

Ground-water levels declined in most of the region, but changed only slightly in Kansas and North Dakota, and rose in much of Nebraska. Levels in the terrace deposits of central Louisiana also rose, in continued response to recharge from the heavy rains of winter and early spring. In southwestern Louisiana, levels in the Chicot aquifer declined sharply as a result of substantial pumping for irrigation. In the Mississippi River alluvial aquifer, levels reached record highs because of the prolonged flood stages. Many irrigation wells in northeastern Louisiana were flowing and levels in wells tapping the alluvial deposits near Baton Rouge were generally 5 to 15 feet above land surface. In Arkansas, the level in the shallow aquifer in the Grand Prairie rice-growing area was unchanged; levels declined in the industrial aquifer (Sparta Sand) in the central and southern parts of the State. Monthend levels were generally above average in Iowa, Kansas, and Nebraska. In Texas, levels rose at Austin, declined at San Antonio and Houston, and were unchanged at El Paso; monthend levels were above average at Austin and San Antonio, but were lowest of record for May at Houston and El Paso. The level in the Ogallala Formation at Plainview was at an alltime low for the period of record.

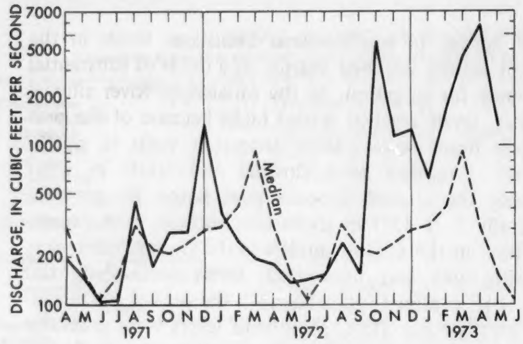
WEST

[Alberta and British Columbia; Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming]

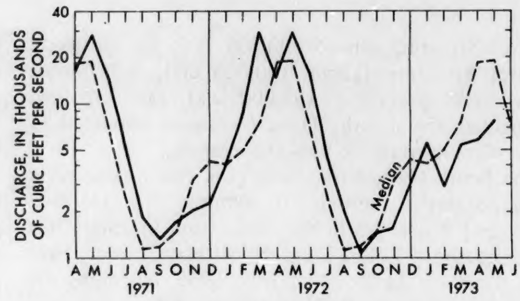
STREAMFLOW INCREASED EXCEPT IN PARTS OF ARIZONA, CALIFORNIA, WASHINGTON, AND OREGON WHERE FLOWS DECREASED SEASONALLY DURING MAY. SOME FLOODING OCCURRED IN COLORADO, UTAH, AND WYOMING. MONTHLY DISCHARGES GENERALLY WERE IN THE NORMAL RANGE IN THE CANADIAN PROVINCES, BELOW NORMAL IN THE NORTHERN STATES AND ABOVE NORMAL IN THE SOUTHERN HALF OF THE REGION.

Streamflow remained in the above-normal range for the 8th or 9th consecutive month in much of Arizona and in southwestern New Mexico. The monthly mean discharge of 2,849 cfs, and the daily mean of 4,150 on May 1, at the index station Little Colorado River near Cameron, Arizona (drainage area, 26,500 square miles) were the highest for May in record that began in 1920. The monthly mean was more than 400 times the May median. In southeastern Arizona, monthly mean flows of Salt River near Roosevelt and Gila River at head of Safford Valley, near Solomon, were the highest for May since 1914 and 1915 respectively. In the adjacent area of southwestern New Mexico, the monthly mean discharge of 720 cfs on Gila River near Gila (drainage area, 1,864 square miles) was highest for May since continuous records began in 1927. In west-central Arizona, flow of Verde River below Tangle Creek, above Horseshoe Dam, remained above the normal range for the 8th consecutive month (see graph on page 9).

In Colorado, moderate flooding occurred along South Platte River in the Denver area and downstream on May 6. The peak discharge of 20,000 cfs was about half that



Monthly mean discharge of Verde River below Tangle Creek above Horseshoe Dam, Ariz. (Drainage area, 5,860 square miles.)



Monthly mean discharge of Spokane River at Spokane, Wash. (Drainage area, 4,290 square miles.)

of the 1965 flood at Denver, but many homes were damaged, one drowning was reported, the 15th Street bridge was destroyed, and damages were estimated at about 50 million dollars by State and local officials. Streamflow in southwestern Colorado was above the normal range as a result of snowmelt runoff.

High rates of snowmelt runoff caused some flooding along many streams in Utah and resulted in failure of a small dam in Payson Canyon, about 30 miles south of Salt Lake City, on May 21. Flood damage in the town of Payson was extensive. Streamflow generally was above the normal range in Utah except in the extreme northern part of the State. The level of Great Salt Lake rose 0.15 foot during the month (to 4,200.55 feet above mean sea level), and was 0.95 foot higher than a year ago.

In the North Platte River basin of southwestern Wyoming, above-normal temperatures and a heavy snowpack produced peak rates of streamflow that were highest of record on Pass Creek near Elk Mountain (1,100 cfs on May 10) where record began in April 1957, and on Laramie River near Fort Laramie, where the peak discharge of 6,200 cfs on May 10 was slightly larger than that of a 100-year flood discharge.

Monthly mean flows remained below the normal range in much of Oregon and Washington, and in northern California, northern Idaho, and western Montana. Low runoff rates in those areas resulted generally from below-normal precipitation, low carryover flow from April, and from light snowpack. For the past four months, below-normal flows have persisted on Spokane River at Spokane, Washington (see graph) and on other streams in Washington and Oregon.

In Nevada, streamflow was above the normal range in all parts of the State because of spring rains falling on a good snowpack. And in the southern part of the Sierra Nevada in California, above-normal snowpack and high temperatures resulted in sharp increases in streamflow into the above-normal range.

Reservoir storage at monthend was near maximum in Nevada and was maximum of record in San Carlos Reservoir in Arizona and in Glendo Reservoir in Wyoming. In southern Idaho, irrigation storage was above average and in northern Idaho, storage for power remained below average. Contents of major reservoirs at monthend were below average in Washington, near average in Colorado, and above average in California, Arizona, and New Mexico. Net increase in storage in the Colorado River Storage Project was 3,361,100 acre-feet.

Ground-water levels generally rose in Montana, in the Boise Valley of southern Idaho, and in east-central Utah. Levels declined in Washington, most of Utah, and in southeastern Arizona and New Mexico. Monthend levels were above average in southeastern Utah, in the Snake Plain aquifer and Boise Valley in southern Idaho, and in the observation well in southern Arizona representative of the irrigated area at the head of Safford Valley (highest for end of May in the 22 years of record). Monthend levels were near average in Nevada (except in heavily pumped areas) and southern California; and below average in Washington, most of Montana and Utah, and in most of southern Arizona and New Mexico.

ALASKA

Streamflow increased seasonally at all index stations in the State, and was in the normal range. The increases were less than usual in central Alaska because of below-average snowpack and cool air temperatures.

Ground-water levels in the Anchorage and Kenai areas reached their seasonal lows and began to rise.

NEW PUBLICATIONS ON TECHNIQUES OF WATER-RESOURCES INVESTIGATIONS

Twenty-nine manuals by the U.S. Geological Survey have been published to date in the series on techniques describing procedures for planning and executing specialized work in water-resources investigations. The four manuals listed below are those that have been published within the last year, supplementing the list of twenty-five manuals that appeared in the April 1972 issue of the *Water Resources Review.* The information in the manual series is grouped under major subject headings called books and is further divided into sections and chapters. For example, Section B of Book 4 (Hydrologic analysis and interpretation) is on surface water. The chapter, the unit of publication, is limited to a narrow field of subject matter. This format permits flexibility in revision and publication as the need arises. The reports listed below are for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

NOTE: When ordering any of these publications from the Superintendent of Documents, please give the title, book number, chapter number, and "U.S. Geological Survey Techniques of Water-Resources Investigations."

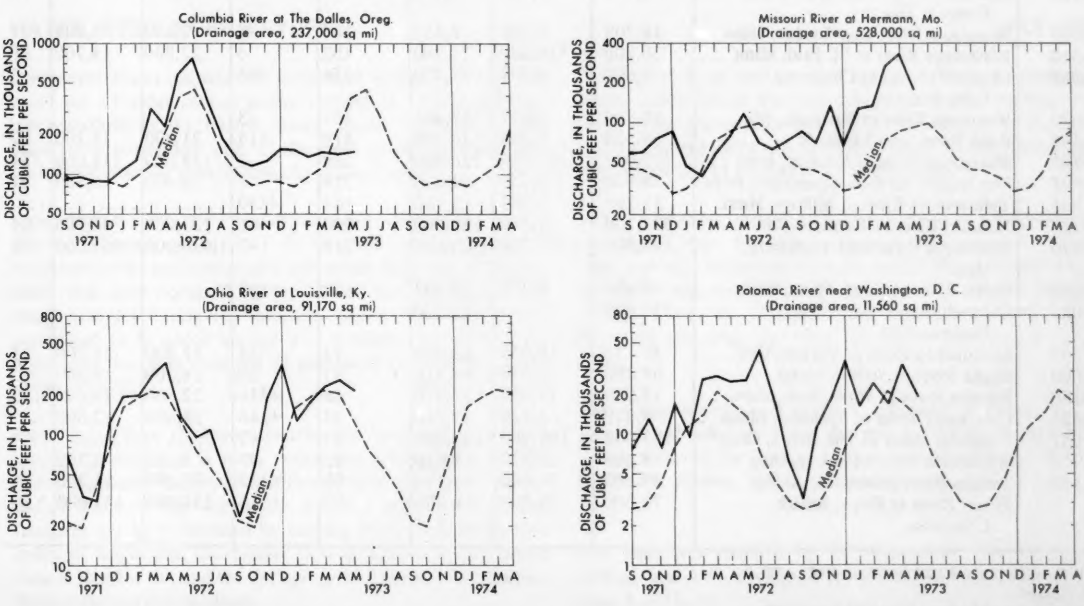
4–B1. *Low-flow investigations,* by H.C. Riggs: USGS—TWRI Book 4, Chapter B1. 1972. 18 pages. $0.55.

4–B2. *Storage analyses for water supply,* by H.C. Riggs and C.H. Hardison: USGS—TWRI Book 4, Chapter B2. 1973. 20 pages. $0.50.

4–B3. *Regional analyses of streamflow characteristics,* by H.C. Riggs: USGS—TWRI Book 4, Chapter B3. 1973. 15 pages. $0.45.

5–A4. *Methods for collection and analysis of aquatic biological and microbiological samples,* by K.V. Slack, R.C. Averett, P.E. Greeson, and R.G. Lipscomb: USGS—TWRI Book 5, Chapter A4. 1973. 165 pages. $3.85.

HYDROGRAPHS OF FOUR LARGE RIVERS



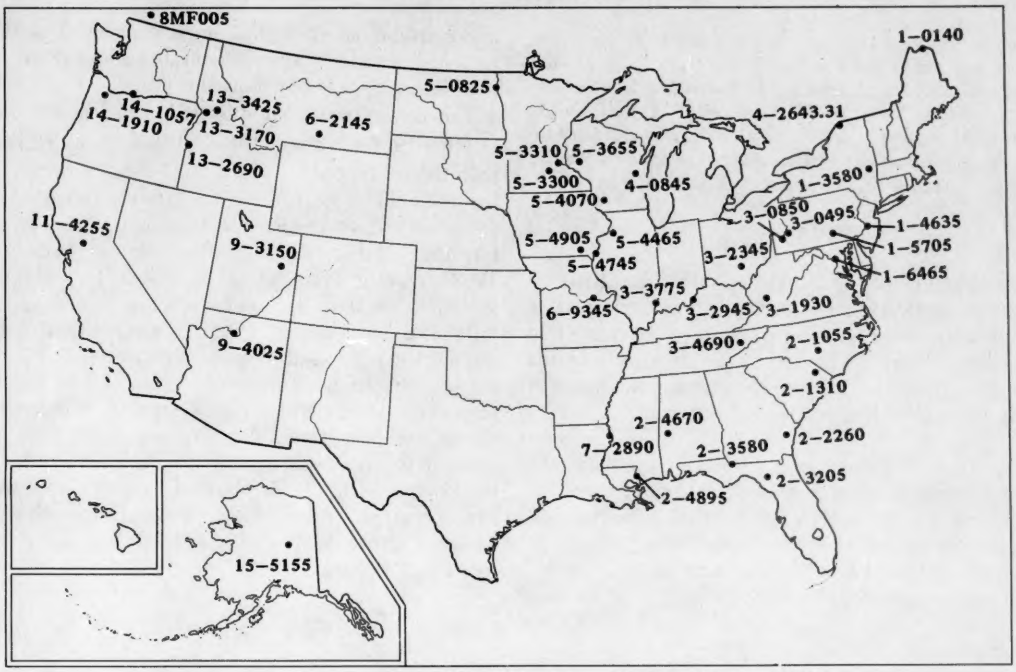
Provisional data; subject to revision

FLOW OF LARGE RIVERS DURING MAY 1973

Station number	Stream and place of determination	Drainage area (square miles)	Mean annual discharge through September 1970 (cfs)	May 1973: Monthly discharge (cfs)	May 1973: Percent of median monthly discharge[1]	May 1973: Change in discharge from previous month (percent)	May 1973: Discharge near end of month (cfs)	May 1973: Discharge near end of month (mgd)	May 1973: Discharge near end of month Date
1-0140	St. John River below Fish River at Fort Kent, Maine.	5,690	9,397	42,200	135	-3	33,700	21,800	31
1-3580	Hudson River at Green Island, N.Y.	8,090	12,520	27,370	173	-11	......	......	....
1-4635	Delaware River at Trenton, N.J	6,780	11,360	24,148	169	-7	27,300	17,600	31
1-5705	Susquehanna River at Harrisburg, Pa.	24,100	33,670	53,850	107	-22	70,000	45,200	31
1-6465	Potomac River near Washington, D.C.	11,560	[2]10,640	19,600	147	-42	43,700	28,200	31
2-1055	Cape Fear River at William O. Huske Lock near Tarheel, N.C.	4,810	4,847	4,552	145	-70	2,740	1,800	29
2-1310	Pee Dee River at Peedee, S.C	8,830	9,098	11,600	163	-63	9,330	6,000	29
2-2260	Altamaha River at Doctortown, Ga.	13,600	13,380	19,770	164	-57	11,200	7,200	25
2-3205	Suwannee River at Branford, Fla	7,740	6,775	24,000	360	-37	15,200	9,800	26
2-3580	Apalachicola River at Chattahoochee, Fla.	17,200	21,690	35,600	177	-40	64,000	41,000	30
2-4670	Tombigbee River at Demopolis lock and dam near Coatopa, Ala.	15,400	21,700	36,640	233	-55	18,600	12,000	25
2-4895	Pearl River near Bogalusa, La	6,630	8,533	24,600	248	-42	5,800	3,700	31
3-0495	Allegheny River at Natrona, Pa	11,410	[2]18,700	28,670	119	+19	21,200	13,700	29
3-0850	Monongahela River at Braddock, Pa.	7,337	[2]11,950	18,990	138	-31	17,700	11,400	29
3-1930	Kanawha River at Kanawha Falls, W.Va.	8,367	12,370	20,750	164	-12	30,000	19,400	31
3-2345	Scioto River at Higby, Ohio	5,131	4,337	5,634	100	-60	7,000	4,500	29
3-2945	Ohio River at Louisville, Ky[3]	91,170	110,600	213,900	159	-15	217,900	140,800	31
3-3775	Wabash River at Mount Carmel, Ill.	28,600	26,310	39,700	115	-52	21,800	14,100	31
3-4690	French Broad River below Douglas Dam, Tenn.	4,543	[2]6,528	14,000	220	+41	......	......	....
4-0845	Fox River at Rapide Croche Dam, near Wrightstown, Wis.[3]	6,150	4,142	15,700	332	+24	......	......	....
4-2643.31	St. Lawrence River at Cornwall, Ontario–near Massena, N.Y.[4]	299,000	239,100	336,700	131	+4	345,000	223,000	31
5-0825	Red River of the North at Grand Forks N. Dak.	30,100	2,439	1,362	30	-32	1,280	800	31
5-3300	Minnesota River near Jordan, Minn ..	16,200	3,306	9,433	185	-5	8,630	5,600	31
5-3310	Mississippi River at St. Paul, Minn ...	36,800	[2]10,230	21,760	102	-5	22,800	14,700	30
5-3655	Chippewa River at Chippewa Falls, Wis.	5,600	5,062	17,470	256	+86	......	......	....
5-4070	Wisconsin River at Muscoda, Wis	10,300	8,457	27,484	259	-3	......	......	....
5-4465	Rock River near Joslin, Ill	9,520	5,288	26,180	419	+15	21,900	14,200	29
5-4745	Mississippi River at Keokuk, Iowa ...	119,000	61,210	226,000	259	-3	179,000	116,000	31
5-4905	Des Moines River at Keosauqua, Iowa.	14,038	5,220	29,000	314	-5	20,600	13,300	31
6-2145	Yellowstone River at Billings, Mont.	11,795	6,754	13,160	101	+169	......	......	....
6-9345	Missouri River at Hermann, Mo	528,200	78,480	182,000	200	-46	131,000	84,700	24
7-2890	Mississippi River near Vicksburg, Miss.[5]	1,144,500	552,700	1,826,000	214	+3	1,490,000	963,000	31
9-3150	Green River at Green River, Utah ...	40,600	6,369	22,603	159	+182	......	......	....
9-4025	Colorado River near Grand Canyon, Ariz.	137,800	....	13,330	....	-58	......	......	....
11-4255	Sacramento River at Verona, Calif ...	21,257	18,370	13,900	72	-24	17,300	11,200	23
13-2690	Snake River at Weiser, Idaho	69,200	17,670	14,310	57	-30	14,200	9,200	....
13-3170	Salmon River at White Bird, Idaho ..	13,550	11,060	21,070	66	+256	22,600	14,600	....
13-3425	Clearwater River at Spalding, Idaho ..	9,570	15,320	17,740	35	+140	18,600	12,000	....
14-1057	Columbia River at The Dalles, Oreg.[6]	237,000	194,000	147,400	44	+3	......	......	....
14-1910	Willamette River at Salem, Oreg	7,280	23,370	7,020	33	-47	4,130	2,700	....
15-5155	Tanana River at Nenana, Alaska	27,500	24,040	30,120	83	+232	39,700	25,700	31
	Fraser River at Hope, British Columbia.	78,300	95,300	174,000	97	+215	234,000	151,000	30

[1]Reference period 1931–60 or 1941–70.
[2]Adjusted.
[3]Record furnished by Corps of Engineers.
[4]Record furnished by Buffalo district, Corps of Engineers, through International St. Lawrence River Board of Control. Discharges shown are considered to be the same as discharge at Ogdensburg, N.Y. when adjusted for storage in Lake St. Lawrence.
[5]Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.
[6]Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.

SELECTED STREAM-GAGING STATIONS ON LARGE RIVERS



Location of stream-gaging stations on large rivers listed in table on page 10.

WATER RESOURCES REVIEW MAY 1973

Cover map shows generalized pattern of streamflow for May based on 22 index stream-gaging stations in Canada and 130 index stations in the United States. Alaska and Hawaii inset maps show streamflow only at the index gaging stations which are located near the points shown by the arrows.

Streamflow for May 1973 is compared with flow for May in the 30-year reference period 1931–60 or 1941–70. Streamflow is considered to be *below normal* if it is within the range of the low flows that have occurred 25 percent of the time (below the lower quartile) during the reference period. Flow for May is considered to be *above normal* if it is within the range of the high flows that have occurred 25 percent of the time (above the upper quartile).

Flow higher than the lower quartile but lower than the upper quartile is described as being within the *normal range.* In the Water Resources Review *normal flow* is defined as the median of the 30 flows of May during the reference period. The normal (median) has been obtained by ranking those 30 flows in their order of magnitude; the highest flow is number 1, the lowest flow is number 30, and the average of the 15th and 16th highest flows is the normal (median). The normal is an average (but not an arithmetic average) or middle value; half of the time you would expect the May flows to be below the median and half of the time to be above the median. Shorter reference periods are used for the Alaska index stations because of the limited records available.

Statements about *ground-water levels* refer to conditions near the end of May. Water level in each key observation well is compared with average level for the end of May determined from the entire past record for that well or from a 20-year reference period, 1951–70. *Changes in ground-water levels,* unless described otherwise, are from the end of April to the end of May.

The Water Resources Review is published monthly. Special-purpose and summary issues are also published. In the United States, issues of the Review are free on application to the Water Resources Review, U.S. Geological Survey, Washington, D.C. 20244.

This issue was prepared by J.C. Kammerer, H.D. Brice, E.W. Coffay, and L.C. Fleshmon from reports of the field offices, June 8, 1973.

CHEMICAL QUALITY OF SURFACE WATER IN THE FLAMING GORGE RESERVOIR AREA, WYOMING AND UTAH

The accompanying abstract, map, and graph are from the report, *Chemical quality of surface water in the Flaming Gorge Reservoir area, Wyoming and Utah,* by R. J. Madison and K. M. Waddell: U.S. Geological Survey Water-Supply Paper 2009-C, 18 pages, 1973. Water-Supply Paper 2009-C (GPO Stock Number 2401-00266) may be purchased for $0.65 from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

ABSTRACT

Construction of Flaming Gorge Dam on the Green River by the U.S. Bureau of Reclamation started in 1959, and storage began in November 1962. A reconnaissance study was made during the period 1966–68 to determine the effects of the reservoir on the chemical quality of the effluent water and to describe the quality of the impounded water and inflowing water.

The major inflow to the reservoir (fig. 1) is from the Green River, which contributes an average of 81 percent of the water and 59 percent of the inflow load of dissolved solids. Together, Blacks Fork and Henrys Fork contribute an average of about 16 percent of the water and about 23 percent of the dissolved-solids load, whereas minor tributaries contribute approximately 3 percent of the total inflow water to the reservoir, but about 18 percent of the total incoming load of dissolved solids.

The concentration of dissolved solids in the reservoir in October 1966 was about 150 mg/l (milligrams per liter) greater than the concentration of the 1962–66 inflow and in September 1968 about 95 mg/l greater than the concentration of the 1962–68 inflow. The increased concentration is due mostly to leaching of minerals from the reservoir bottom. For the 1963–68 water years, about 1.2 million tons of dissolved solids was leached from inundated areas. The major observable difference between the chemical composition of the inflow during 1963–66 and that of the reservoir in 1966 is an increase in the percentage of sulfate and a decrease in the percentage of bicarbonate. Impoundment of water in Flaming Gorge Reservoir during the 1963–68 water years caused the concentration of dissolved solids in the river system to increase by 130 mg/l (fig. 2), or about 32 percent over what would have occurred without the reservoir. Evaporation accounted for an increase of 15 mg/l, and leaching accounted for an increase of 115 mg/l.

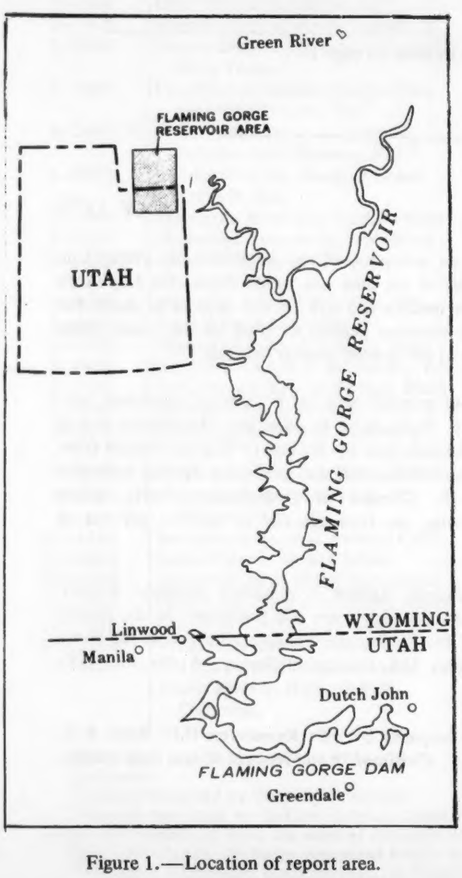


Figure 1.—Location of report area.

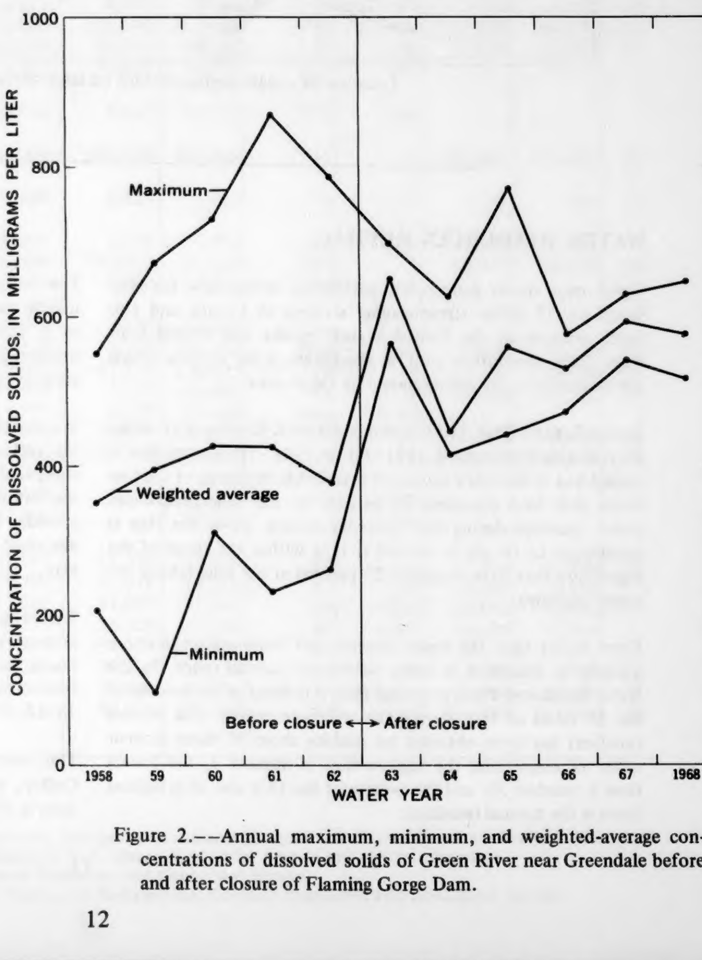


Figure 2.—Annual maximum, minimum, and weighted-average concentrations of dissolved solids of Green River near Greendale before and after closure of Flaming Gorge Dam.